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(71) Applicant (for all designated States except US): VISION 1 IN-TERNATIONAL LIMITED [GB/GB]; Broughton, Biggar ML12 6HQ (GB).

(72) Inventor; and
(75) Inventor/Applicant (for US only): VELLACOTT, Oliver, Richard [GB/GB]; Galavale House, Broughton, Biggar ML12 6HQ (GB).

(74) Agent: MURGITROYD & COMPANY; Chartered Patent Agents, 373 Scotland Street, Glasgow G5 8QA (GB).

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(54) Title: DIGITALLY NETWORKED VIDEO CAMERA
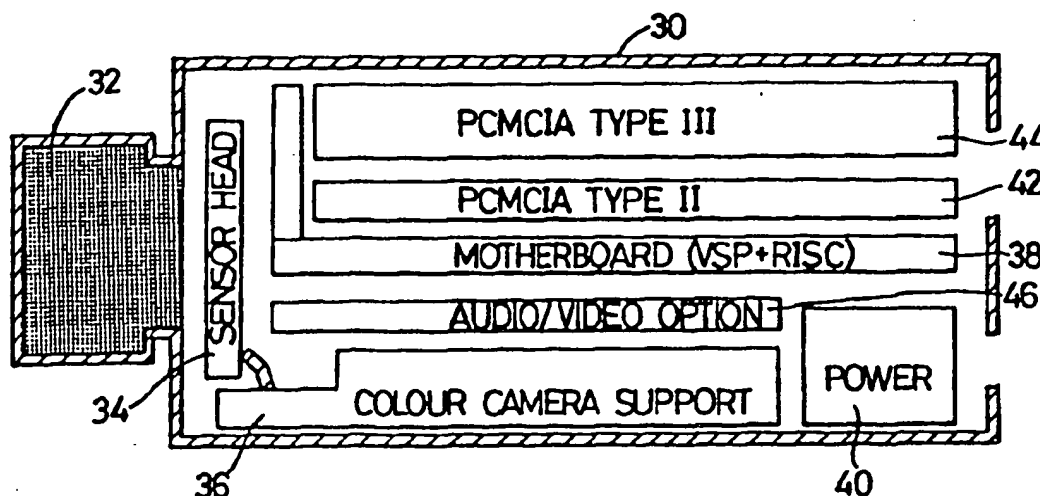
PHYSICAL CONFIGURATION.

(57) Abstract

A self-contained, digitally networked video camera comprises a housing (30) enclosing a camera module having video image sensor means (36) adapted to generate a video signal, signal processing means (38), including a video signal processor (VSP) which receives a digital video signal from the camera module and a multi-tasking RISC processor, adapted to compress and/or analyse said video signal and to output a digital data signal, and digital interface input/output means (42, 44), such as PCMCIA cards adapted to transmit said digital data signal to an external, digital communications network in accordance with a predetermined communications protocol, such as TCP/IP. The camera may be connected directly to a digital communications network, such as a LAN or WAN, for the transmission of compressed, digital video signals and/or associated data directly to host PC's connected to the network. Audio signals may also be processed.

DIGITALLY NETWORKED VIDEO CAMERA

1

2

3   This invention relates to improvements in video camera

4   apparatus. More particularly, the invention relates to

5   video cameras adapted for direct connection to digital

6   communications networks, and to video cameras which can

7   analyse what they see and/or hear and which can

8   interface directly to digital networks.

9

10   In this field it is already known that:

11

12   1   Cameras can be interfaced to digital networks via

13   PC's or separate dedicated control units (see, for

14   example, GB-A-2231753; US-A-5237408; WO-A-

15   90/09717).

16

17   2   Videophones can interface directly to some digital

18   networks (WAN - Wide Area Networks) but are unable

19   to perform image analysis or audio analysis for

20   the purpose of detecting specific events and

21   moreover cannot interface directly to Local Area

22   Networks (LAN).

23

24   3   Analysis of images has been carried out within a

25   camera unit (such systems are available from, for

26   example, VLSI Vision Limited of Edinburgh, UK;

27   Intelligent Camera, Image Inspection Limited of

28   Epsom, UK; and MAPP/LAP, IVP, Linkoping, Sweden)

2

1   but never in conjunction with the ability to
2   interface directly to digital networks.
3
4   Known cameras and systems of these types have the
5   disadvantages that:
6
7   1   It is often impractical and not cost effective to
8   use a PC or separate control unit to allow a
9   camera to interface to LAN/WAN. This is
10   especially true in circumstances where a PC would
11   not usually be present such as in remote
12   surveillance applications: eg construction site
13   monitoring.
14
15 2   Existing surveillance cameras, by transmitting
16   video in analogue form, are severely restricted
17   in quality of transmission and recording,
18   automation of surveillance operations,
19   restrictions on network topologies, ability to
20   cross-reference to other events whose occurrence
21   is reported digitally.
22
23 3   Existing cameras which can perform image analysis
24   cannot transmit images and the results of analysis
25   over digital networks, thus severely restricting
26   interpretation of results and integration of
27   cameras with existing digital systems.
28
29 Use of digital cameras is almost exclusively oriented
30 around PC's and workstations. The requirement for a
31 host PC for capturing and transmitting video is
32 circumvented by this invention. This is achieved by
33 the integration of the hardware and software previously
34 provided by the combination of a camera and separate
35 computer (PC) into a single, stand-alone surveillance
36 camera unit.

1   The benefits of this are (a) the cost reduction through
2   not requiring a PC to be present and (b) the
3   flexibility achieved by enabling image input to digital
4   networks from locations where PC's cannot be used.
5
6   This, combined with the ability to automatically
7   analyse the acquired video and/or audio, within the
8   camera and in real time, allows the automation of a
9   wide range of visual/audio tasks via remote control
10   over digital networks.
11
12   In accordance with the present invention there is
13   provided a video camera comprising a housing enclosing
14   video image sensor means adapted to generate a video
15   signal, signal processing means adapted to process said
16   video signal and to output a digital data signal, and
17   digital interface input/output means adapted to
18   transmit said digital data signal to an external,
19   digital communications network in accordance with a
20   predetermined communications protocol.
21
22   Preferably, said signal processing means includes a
23   video signal processor (VSP) adapted to perform real-
24   time image compression and/or image analysis on said
25   video signal.
26
27   Preferably also, said signal processing means further
28   includes microprocessor means adapted to supervise
29   operation of said VSP and data input/output via said
30   interface means.
31
32   Most preferably, said microprocessor means comprises a
33   multi-tasking RISC processor.
34
35   Preferably also, said VSP has first memory means
36   associated therewith. Suitably, said first memory means

1   comprises dynamic random access memory.

2

3   Preferably also, said microprocessor means has second
4   memory means associated therewith. Suitably, said
5   second memory means comprises static random access
6   memory.

7

8   Preferably also, said communications protocol is
9   TCP/IP.

10

11   Preferably also, said interface means comprises at
12   least one PCMCIA card.

13

14   Preferably also, the camera further includes audio
15   sensor means, said signal processing means being
16   further adapted to process audio signals generated by
17   said audio sensor means.

18

19   While further modifications and improvements may be
20   made without departing from the scope of this
21   invention, the following is a description of one or
22   more examples of the invention, with reference to the
23   accompanying drawings in which:

24

25   Fig. 1 is a schematic illustration of a video
26   camera in accordance with the invention
27   connected to a digital network such as a LAN
28   or WAN;

29

30   Fig. 2 is a schematic block diagram
31   illustrating the hardware architecture of the
32   camera of Fig. 1;

33

34   Fig. 3 is a schematic illustration of the one
35   example of the physical configuration of the
36   camera of Fig. 1; and

1   Fig. 4 is a schematic block diagram
2   illustrating the software architecture of the
3   camera of Fig. 1.
4
5   The invention relates to a camera which can interface
6   directly to digital networks (such as Local Area
7   Networks (LAN's) or Wide Area Networks (WAN's)) and
8   which can carry out real time image compression and
9   analysis. Via the LAN/WAN it can communicate to one or
10   more PC control stations where the compressed video can
11   be decompressed and displayed and the results of the
12   image analysis viewed and/or recorded in a database.
13
14   Fig. 1 illustrates an example of such an arrangement,
15   in which one or more cameras 10 are connected directly
16   to the network 12, to which there are also connected
17   one or more host PC's 14. The camera 10 digitises,
18   compresses and analyses video images of a subject 16,
19   and the images and/or associated analysis results are
20   transmitted via the network 12 for display and/or
21   recordal on the host PC 14.
22
23   The hardware architecture of the camera 10 is
24   illustrated in block-diagram form in Fig. 2. As seen
25   in Fig. 2, the digitally-networked camera combines a
26   colour camera 18, including an image sensor and,
27   optionally, audio microphone, with a high performance
28   Video Signal Processor (VSP) 20 and a RISC processor
29   22. The output video/audio signals from the camera 18
30   are input to the VSP 20, which is connected to the
31   RISC processor 22. The processor 22 is in turn
32   connected to network interface hardware 24. Both the
33   VSP 20 and RISC processor 22 have memory means
34   associated therewith. In this example, dynamic random
35   access memory (DRAM) 26 is connected to the VSP 20 and
36   static random access memory (SRAM) and programmable

6

1   read only memory (PROM, preferably Flash EPROM) 28 is

2   connected to the RISC processor 22.

3

4   The colour camera 18 may be of the type including an

5   image sensor which directly outputs a digital video

6   signal, or may have an analogue sensor output with

7   separate analogue to digital conversion, or analogue to

8   digital conversion means may be incorporated between an

9   analogue camera and the VSP 20. In any case, the input

10   to the VSP 20 is a digital video signal. The same

11   applies to audio signals from the camera 18, if

12   applicable.

13

14   The VSP 20 supports real time image compression and

15   also acts as a highly parallel ALU for real time image

16   analysis. The RISC processor 22 supports a

17   multitasking operating system with built-in networking

18   and communications support, and also supervises the VSP

19   20. External input/output (i/o) is via the network

20   interface hardware 24; suitably, for example, via two

21   PCMCIA slots, allowing easy interfacing to LAN, WAN,

22   ISDN, wireless communications and mass storage devices.

23   It will be appreciated that digital network interfaces

24   may be provided by means other than PCMCIA-type

25   devices.

26

27   The camera also includes a proprietary digital gate

28   array (not shown), which implements bus bridges between

29   the major functional units of the architecture and

30   contributes to the high integration and low cost of the

31   camera unit.

32

33   This entire functionality is integrated within a single

34   camera unit. Fig. 3 shows an example of the physical

35   configuration of such a unit. In Fig. 3, a housing 30

36   supports the camera optics 32 and encloses the image

7

1   sensor 34 and associated electronics 36 of the camera
2   18; a motherboard 38 mounting the VSP 20, RISC
3   processor 22, DRAM 26, SRAM 28 and other associated
4   electronic components; a power supply unit 40; network
5   interface hardware such as type II and type III PCMCIA
6   cards 42, 44; and, possibly, additional, optional
7   audio/video hardware 46. It will be understood that
8   the illustrated physical configuration is given by way
9   of example only and may be varied while still
10   maintaining the essential functionality of the
11   invention.
12
13   The RISC processor 22 supervises the execution of image
14   processing and/or compression functions performed by
15   the VSP 20. The RISC processor 22 also supports a
16   real-time operating system (RTOS). The software
17   architecture of the camera is illustrated
18   schematically in Fig 4. This allows genuine
19   multitasking, which is essential in the environment.
20   In parallel, the RISC processor 22 supervises video
21   capture, compression, image processing, audio capture
22   and analysis, and PCMCIA i/o. Context switches must be
23   accomplished within a guaranteed time for this to be
24   effective. Normal multitasking facilities are
25   provided, such as message passing, mailboxes,
26   preemptive/round-robin/time-slice scheduling, interrupt
27   handling, etc.
28
29   Various communication protocol stacks may be supported
30   by the RTOS. Preferably, TCP/IP is implemented as the
31   high level network communications protocol. This
32   allows each camera to be assigned a unique internet
33   address and simplifies communications between cameras,
34   and between cameras and host PC's, across multiple
35   heterogeneous networks.
36

8

1   The advantages of the invention and/or the ways in
2   which the disadvantages of previously known
3   arrangements are overcome, include the following.
4
5   1.   General
6
7   The Digitally-networked Camera is designed for real
8   time video capture, compression, analysis and
9   transmission in circumstances where it is either
10   impractical or not cost effective to use a host PC.
11   Since the camera operates stand-alone it can be plugged
12   directly into computer networks or deployed remotely in
13   the field using wireless communications.
14
15   2.   Security & Surveillance
16
17   The digitally-networked camera contains the total
18   functionality required for analogue-networked
19   surveillance systems to migrate to digitally-networked
20   systems._ Real-time video/audio compression allows
21   continuous transmission over existing LAN's without
22   significant degradation in LAN performance.
23
24   Since the Digitally-networked Camera performs real time
25   image processing, specific events can be detected and
26   reported to personnel. This will dramatically raise
27   the effectiveness of surveillance. The audio option
28   can be used to assist in detection of certain security
29   events including shrieks, breaking of glass, etc.
30
31   Thus, the invention allows semi-automation of security
32   surveillance systems. This has the potential to
33   significantly improve the cost-effectiveness of such
34   systems.
35
36   3.   Traffic monitoring

1   The Digitally-networked Camera can be programmed to

2   analyse traffic speeds, congestion, vehicle

3   numberplates, etc and can directly report these

4   statistics and/or compressed video to a control centre

5   via a WAN, eg an ISDN/phone line.

6

7   4.   Video-Conferencing

8

9   The Digitally-networked Camera can participate in PC-

10   based video conferences, transmitting compressed video

11   from locations where PC's cannot be used, such as

12   construction sites (wireless LAN) and factory shop

13   floors.

14

15   5.   Industrial Inspection & Process Control

16

17   The invention allows automation of industrial

18   inspection, integrated with existing LAN's for

19   communication of inspection results to controller PC's

20   and control of cameras from PC's.

21

22   6.   Miscellaneous

23

24   The wide range of PCMCIA cards available allows a

25   diverse range of applications to be addressed. For

26   example, to match images captured remotely with the

27   location at which they were captured it is possible to

28   use a GPS receiver card to let the camera get a fix on

29   the position of capture. This might be combined with a

30   cellular comms card to transmit the picture+location

31   immediately back to base.

32

33   Improvements and modifications may be incorporated

34   without departing from the scope of the invention as

35   defined in the Claims appended hereto.

36

1   Claims

2

3   1.   A video camera comprising a housing enclosing

4   video image sensor means adapted to generate a video

5   signal, signal processing means adapted to process said

6   video signal and to output a digital data signal, and

7   digital interface input/output means adapted to

8   transmit said digital data signal to an external,

9   digital communications network in accordance with a

10   predetermined communications protocol.

11

12   2.   A video camera as claimed in Claim 1, wherein

13   said signal processing means includes a video signal

14   processor (VSP) adapted to perform real-time image

15   compression and/or image analysis on said video signal.

16

17   3.   A video camera as claimed in Claim 2, wherein

18   said signal processing means further includes

19   microprocessor means adapted to supervise operation of

20   said VSP and data input/output via said interface

21   means.

22

23   4.   A video camera as claimed in Claim 3, wherein said

24   microprocessor means comprises a multi-tasking RISC

25   processor.

26

27   5.   A video camera as claimed in Claim 2, wherein said

28   VSP has first memory means associated therewith.

29

30   6.   A video camera as claimed in Claim 5, wherein said

31   first memory means comprises dynamic random access

32   memory.

33

34   7.   A video camera as claimed in Claim 3, wherein said

35   microprocessor means has second memory means associated

36   therewith.

11

1   8.   A video camera as claimed in Claim 7, wherein said
2   second memory means comprises static random access
3   memory and programmable read only memory.
4
5   9.   A   video camera as claimed in Claim 1, wherein
6   said communications protocol is TCP/IP.
7
8   10.   A video camera as claimed in Claim 1, wherein said
9   interface means comprises at least one PCMCIA card.
10
11   11.   A   video camera as claimed in Claim 1, further
12   including audio sensor means, wherein said signal
13   processing means   is further adapted to process audio
14   signals generated by said audio sensor means.
15

1/2
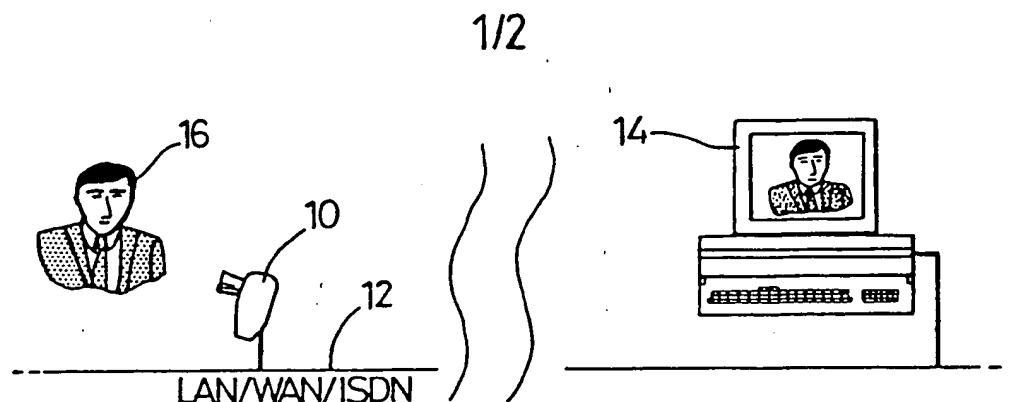
Fig.1 THE CAMERA INTERFACES DIRECTLY TO LAN/WAN
AND THEREBY, CAN OPERATE UNDER CONTROL OF
ONE OR MORE ATTACHED PCs/WORKSTATIONS.
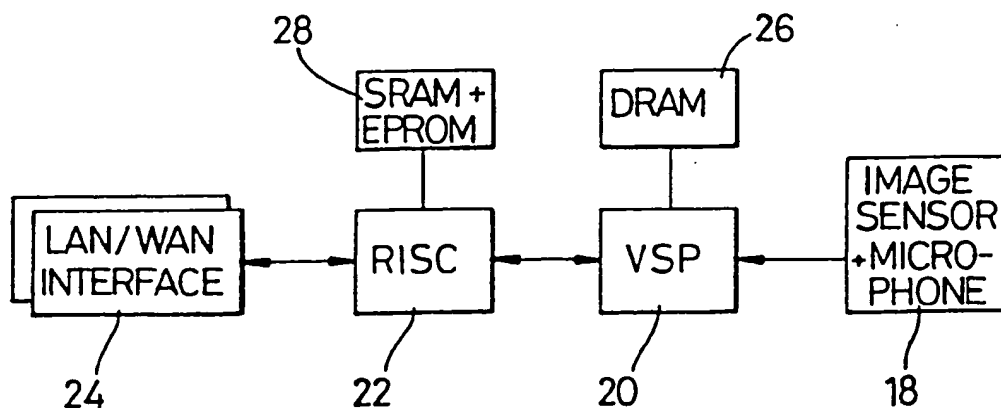
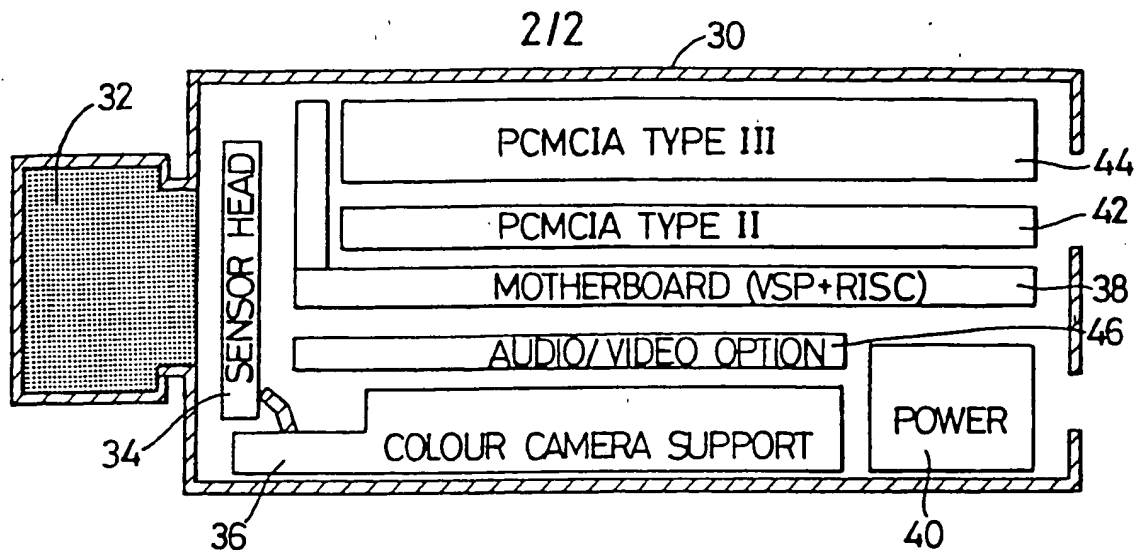**Fig. 2** HARDWARE ARCHITECTURE OF INVENTION
ALLOWING CAMERA UNIT TO ATTACH
DIRECTLY TO DIGITAL NETWORKS.

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2/2

Fig. 3 PHYSICAL CONFIGURATION.

Fig. 4 SOFTWARE ARCHITECTURE OF CAMERA,
ALLOWING IMAGE ANALYSIS IN CONJUNCTION
WITH IMAGE COMPRESSION AND TRANSMISSION
OVER DIGITAL NETWORK.

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